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April 19, 2005

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APPLICATION NUMBER: *60/556,713*
FILING DATE: *March 26, 2004*
RELATED PCT APPLICATION NUMBER: *PCT/US05/09338*

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV 389269766 US

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Paul T.	Wegener	San Diego, CA

Additional inventors are being named on the _____ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

Configurations and Methods For Wave Energy Extraction

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

[X] Customer Number: 34284

OR

[ ] Firm or Individual Name					
Address					
Address					
City		State		Zip	
Country		Telephone		Fax	

ENCLOSED APPLICATION PARTS *(check all that apply)*

[X] Specification *Number of Pages* 6
[ ] Drawing(s) *Number of Sheets* _____
[ ] Application Data Sheet. See 37 CFR 1.76
[ ] CD(s), Number _____
[ ] Other (specify) _____

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

[X] Applicant claims small entity status. See 37 CFR 1.27.
[ ] A check or money order is enclosed to cover the filing fees.
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FILING FEE Amount ($): 80.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

[X] No.
[ ] Yes, the name of the U.S. Government agency and the Government contract number are: _____

[Page 1 of 1]

Respectfully submitted,

SIGNATURE _____

TYPED or PRINTED NAME Martin Fessenmaier

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Date 03/26/04

REGISTRATION NO. 46697 *(If appropriate)*

Docket Number: 100673.0010PRO

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FEE TRANSMITTAL for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 80.00

Complete if Known	
Application Number	
Filing Date	March 26, 2004
First Named Inventor	Paul T. Wegener
Examiner Name	
Art Unit	
Attorney Docket No.	100673.0010PRO

METHOD OF PAYMENT *(check all that apply)*

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	80.00

SUBTOTAL (1) ($) 80.00

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

	Extra Claims		Fee from below	Fee Paid
Total Claims		-20** =	X	=
Independent Claims		-3** =	X	=
Multiple Dependent				=

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	88	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	88	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($)

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FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for *ex parte* reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid **SUBTOTAL (3)** ($)

SUBMITTED BY				(Complete *if applicable*)	
Name (Print/Type)	Martin Eessenmaier	*Registration No. (Attorney/Agent)*	46697	*Telephone*	714-641-5100
Signature				*Date*	March 26, 2004

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CONFIGURATIONS AND METHODS FOR WAVE ENERGY EXTRACTION

Field of The Invention

Energy generation using wave energy.

Background of The Invention

Ocean waves have been regarded as a potential source for energy extraction for over 200 years and many devices have been constructed to that end. However, all or almost all of the currently known devices fail to extract sufficient energy in an economic manner.

For example, many wave energy harvesters utilize alternating peaks and troughs of ocean waves to raise and lower part of the harvester to thereby extract mechanical energy from relative motions of at least two portions of the device. Motion of one portion of such devices is typically due to flotation on the rising and falling water surface as a wave passes the device which is in a relatively fixed position. Since the quantity of energy harvested is directly proportional to the weight of the device on the down stroke, or the buoyancy force on the upstroke, most known devices lag the wave. Typically, such devices sink as the water rises until relative buoyancy increases sufficiently to force the device upwards, and then emerge onto or above the water surface as the wave falls, since the downward stroke is used to extract energy from the device. As such devices are based on buoyant forces generated by the up-and-down motion of the wave, they are also known as point-absorbers.

For point absorbers which use buoyancy as the predominant actuating force, a float or other buoyant portion is tethered to a structure below the surface and the upward pull on the tether transmits the force that is harvested as energy. An exemplary device is described at the web address http://www.seapower.cc/. In such devices, the buoyant floats are attached to a fixed point via a flexible tether, and therefore are subject to tilting of the float upon forward force impingement of a wave. Moreover, due to the V-shaped cross-section of the buoyant floats, the floats will typically submerge further than a comparably sized flat float.

In other known waver energy generators, the forward momentum of a wave is exclusively used. Such devices are commonly known as oscillating water column devices, in which the wave

rushing into a cavity pushes air out of the cavity through a turbine. Alternatively, such devices allow a wave crest to rush into a cavity that is hydraulically coupled to one or more turbine. An exemplary device is described at the web address http://www.waveplane.com. Depending on the location, the forward momentum of a wave is substantial, and most clearly evidenced in breaking waves or waves used by surfers. While such wave energy harvesters are often mechanically more simple and operate at relatively high efficiencies, various disadvantages remain. Among other things, only a portion of the wave energy is translated into harvested energy, and potentially usable energy from the up-and-down motion of the wave are typically lost.

Therefore, although numerous wave energy harvesters are known in the art, all or almost all of them suffer from one or more disadvantages. Consequently, there is still a need to provide improved configurations and devices for wave energy extraction.

Detailed Description

The inventors discovered that the forward and backward movement of water during wave movement as well as the up and down movement of water during wave movement can be extracted in a single device in which a hydrofoil or hull translates the forward and backward movement of water into an increased up and down movement, which can be extracted in numerous known manners. Contemplated configurations and devices may also be employed to stabilize a floating device against the up and down and/or side-to-side buoyant forces of waves, or to increase such motion where desired. In one exemplary and generally contemplated aspect, a planing hull shape or hydrofoil is coupled to the bottom of a flat float.

Waves are epiphenomena, the propagation through time and space of an original disturbance, whose energy is propagated by imparting motion to water elements. This vorticity gives the appearance of the rise and fall of the water surface. The horizontal profile of a wave is, however, in a first approximation a cycloid. Therefore, the water in a wave is actually in motion. At the top of the peak, the water is moving forward with the speed of the wave itself, while in the trough the water is moving backwards with a much lower velocity. As the wave peak approaches, the water elements rise, and as it recedes, they fall. Here we propose to generate force from the actual movement of the water elements to extract energy from the wave.

Waves travel at characteristic velocities, which for significant ocean waves range from 10 to 40 km per hour. These are the speeds used to generate lift from hydrofoils or induce planing in speedboats. Because water is so much denser than air, one can generate considerable lifting force from a relatively small shape. Thus, it should be appreciated that by incorporating a lifting shape into the moving element of a wave energy harvester, one can increase the height attained at the peak of the wave. Moreover, by appropriate design, the same elements can pull the moving element down during the reverse motion of the trough.

As an example for such a concept, a known energy harvester (*e.g.*, as described in U.S. Pat. No. 6,045,339) is modified by adding hydrofoils to at least one of the floats. As originally described, the wave harvester of the '339 patent uses three floats attached by arms to a triangular central float. As the arm floats move up and down relative to the central float, the arms actuate pumps to harvest the energy. The power output of the device is determined by the height reached by the floats, which is limited by the height of the waves. As can be readily recognized, hydrofoil elements coupled to the device below the floats, or an angled or planing hull design of the floats, or a combination, would lift the floats higher at the peak of the wave. Therefore the device would harvest more energy on each down stroke. Moreover, in the case of open hydrofoil elements in the water below the floats, the reversed horizontal flow in the trough of the wave would pull the float down below its neutral buoyancy, therefore increasing the travel of the pump and the energy harvested even further.

It should further be appreciated that the lift generated by the forward motion of the wave will increase the drag on the device in the direction of the wave travel. However, the reverse flow during the trough will counteract such drag by pulling the device back towards the following peak, so overall, hydrofoil additions will not increase the net force on the tether more than the net forward motion of the water elements, which is minor. However, hydrofoil elements will increase drag on the tether of a simple bobbing device. The drag of hydrofoil elements on devices with multiple floats in various portions of the wave, such as the "wave motor" of the '339 patent above, will experience only the small increase in net drag.

Any floating device will be subject to waves, and therefore it rises and falls, or tilts, depending on size. In the case of floating platforms, such tilting may be undesirable. Using

contemplated configurations and methods presented herein, it should also be appreciated that elements may be coupled to a floating device that counteract the buoyant force of the waves by generating an opposing force from the forward and backwards movement of the water elements. Since the height of the wave (i.e., the buoyant force) and its velocity are correlated, such dampening will be effective over a range of wave heights. Design criteria for hydrofoils are well understood and attaching a hydrofoil array to a floating device to counteract wave motion is straightforward. In some cases, such as a bell buoy, the motion caused by waves is desirable, as it actuates the bell. Consequently, in such cases the added elements can be configured to increase the motion caused by the waves.

Moreover, it is not necessary to use buoyancy as a source of power extraction from waves. An individual element of water rises and falls as the wave passes, yet it has no net buoyancy; the force that raises it is simply the upward motion of the water element immediately below it. For example, consider a balloon containing seawater and a small bubble of air will barely float at the surface. The density of this balloon does not differ substantially from the water around it. The balloon will rise and fall with the waves. If one attaches an energy harvesting apparatus to the balloon, one can resist the downward motion of the balloon, lifting it from the surface of the water as the wave recedes, and obtain energy from the weight of the no-longer submerged water mass it contains. If the balloon is re-submerged before the arrival of the next wave, it will be raised by the hydrodynamic upward force, regenerating the potential energy harvested during the downward fall. This harvesting takes place without any buoyant effect.

Therefore, a point absorber can be designed with neutral buoyancy that utilizes only the upward force of the water elements of the waves. This device will not suffer from the defect outlined above, such that the device must be submerged below its flotation height for a buoyant force to develop, but instead the neutrally buoyant weight will be raised the full height of a water element at its average depth. Therefore, the thinner such a device is, the higher it will rise with the wave and the more useful energy can be extracted by resisting its fall. Specifically, such an element should be confined to the upper layer of the ocean. It should act upon another element of the wave energy harvester during its fall as a wave recedes so that the neutral buoyancy is transformed into a net weight falling through the distance it had been raised, by which energy is

extracted. Oscillation between two or more connected elements, all of which are neutrally buoyant, is also contemplated here.

An additional advantage of neutral buoyancy is that during a storm, the top layers of the ocean become churned by the breaking waves and therefore the water is filled with bubbles, reducing its density. Any object of neutral buoyancy will sink to the interface with the undisturbed water below this churned layer, and therefore be protected from the extreme motions of the waves at the surface. Therefore, a wave energy harvester that is neutrally buoyant overall will become submerged during a storm and be protected by a layer of water until the storm passes. Such a neutrally buoyant wave energy harvester can use the horizontal motion of the water to amplify the relative motion of its elements as well as the hydrodynamic forces to harvest wave energy.

Thus, specific embodiments and applications of energy extraction of waves have been disclosed. It should be apparent, however, to those skilled in the art that various modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the present disclosure. Moreover, in interpreting the specification, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

CONTEMPLATED CLAIMS

What is claimed is:

1. A wave energy harvester comprising a moving element shaped to translate forward velocity of water of a wave into an upward force

2. The wave energy harvester of claim 1 wherein the moving element comprises a lifting or planing hull.

3. A wave energy harvester comprising hydrofoil element that produces a bi-directional force from horizontal motion of water of a wave, the bi-directional force being directed upwards during a peak of the wave and downwards during a trough of the wave.

4. A floating device comprising a hydrofoil configured to reduce or amplify a buoyant force of a wave passing the device.

4. A wave energy harvester of neutral buoyancy comprising a moving element that is configured such that the element is raised by forward water motion of a wave moving past the harvester, and such that energy is extracted by resisting lowering of the element following passage of the wave.

5. A wave energy harvester of neutral buoyancy, configured such that the harvester becomes submerged when a storm churns a water surface to thereby reduce density of the surface.

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
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(PCT Administrative Instructions, Section 411)

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ETATS-UNIS D'AMERIQUE

Date of mailing *(day/month/year)* 02 August 2005 (02.08.2005)	
Applicant's or agent's file reference 100673.0010P	**IMPORTANT NOTIFICATION**
International application No. PCT/US2005/009338	International filing date *(day/month/year)* 21 March 2005 (21.03.2005)
International publication date *(day/month/year)*	Priority date *(day/month/year)* 26 March 2004 (26.03.2004)
Applicant EPITOME PHARMACEUTICALS LIMITED et al	

1. By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. *(If applicable)* The **letters "NR"** appearing in the right-hand column denote **a priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau** under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

3. *(If applicable)* **An asterisk (*)** appearing next to a date of receipt, in the right-hand column, denotes **a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b)** (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
26 March 2004 (26.03.2004)	60/556,713	US	25 April 2005 (25.04.2005)

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